

Maciej Zworski

<i>Office</i>	Addresses	<i>Home</i>
801 Evans Hall Mathematics Department University of California Berkeley, CA 94720 http://math.berkeley.edu/~zworski		2135 California Street Berkeley, CA 94703

Research Interests

Partial Differential Equations, Microlocal Analysis, Scattering Theory.

Education

<i>Massachusetts Institute of Technology</i> Ph.D. in Mathematics Thesis Advisor : Professor R.B. Melrose Thesis title : High Frequency Scattering by a Convex Obstacle.	<i>September 1985–June 1989</i>
<i>Massachusetts Institute of Technology</i> S.B. in Mathematics.	<i>September 1983–June 1985</i>
<i>Imperial College, London, U.K.</i> B.Sc. programme in the Department of Mathematics.	<i>October 1982–June 1983</i>

Experience

<i>Professor of Mathematics, University of California, Berkeley</i>	<i>1998–date</i>
<i>Vice-Chair for Faculty Affairs, Mathematics, UC Berkeley</i>	<i>2006–2009</i>
<i>Professor of Mathematics, University of Toronto</i>	<i>1995–2000</i>
<i>Professor of Mathematics, The Johns Hopkins University</i>	<i>1994–1996</i>
<i>Associate Professor of Mathematics, The Johns Hopkins University</i>	<i>1992–1993</i>
<i>Benjamin Peirce Lecturer, Assistant Professor of Mathematics, Harvard University</i>	<i>1989–1992</i>

Professional Activities

<i>Chair, Conseil scientifique, Fondation mathématique Jacques Hadamard</i>	<i>2011–2016</i>
<i>Member, Scientific Advisory Panel of The Fields Institute, Toronto</i>	<i>2009–2013</i>
<i>Founding Editor-in-Chief, Analysis & PDE (Math Sci Publishers)</i>	<i>2007–2016</i>
<i>Editor, Analysis & PDE (Math Sci Publishers)</i>	<i>2016–date</i>
<i>Editor, Applied Mathematics Research eXpress</i>	<i>2006–date</i>
<i>Associate Editor, Inverse problems and imaging</i>	<i>2006–date</i>
<i>Associate Editor, American Journal of Mathematics</i>	<i>2006–date</i>
<i>Associate Editor, Canadian Journal of Mathematics</i>	<i>2001–2006</i>
<i>Editor, Methods and Applications of Analysis</i>	<i>2001–date</i>

<i>Editor, American Journal of Mathematics</i>	2000–2005
<i>Editor, International Mathematics Research Notices</i>	1998–2006
<i>Associate Editor, Duke Mathematical Journal</i>	1992–2000

Fellowships and Honours

<i>Miller Research Professor, University of California, Berkeley</i>	Fall 2015
<i>Faculty Mentor Award of the Graduate Assembly, University of California, Berkeley</i>	2014
<i>Chaire d'Excellence, Université de Paris-Nord</i>	2011
<i>Fellow of American Academy of Arts and Sciences</i>	2010–date
<i>BMC/BAMC superplenary speaker</i>	2010
<i>ICM speaker in the PDE section</i>	2002
<i>Fellow of Royal Society of Canada</i>	1999–date
<i>Coxeter-James Prize of the Canadian Mathematical Society</i>	1999
<i>Fellow of Trinity College, University of Toronto</i>	1996–date
<i>Alfred P. Sloan Research Fellow</i>	1991–1993
<i>Sloan Doctoral Dissertation Fellow</i>	1988–1989
<i>Jon A. Bucsela Prize in Mathematics, MIT</i>	1985

Visiting Positions

<i>Visiting Professor, Institut Henri Poincaré</i>	June 2015
<i>Visiting Professor, Université de Paris-Sud, Orsay</i>	May 2009
<i>Visiting Directeur de Recherche, CNRS, École Polytechnique</i>	September–December 2004
<i>Visiting Professor, Université de Paris-Nord</i>	October 2003
<i>Visiting Professor, Université de Paris-Sud, Orsay</i>	September 2003
<i>Programme Organizer, MSRI</i>	January–May 2003
<i>Visiting Professor, Université de Paris-Sud, Orsay</i>	June 2002
<i>Programme Organizer, Erwin Schrödinger Institute, Vienna</i>	May–July 2001
<i>Visiting Professor, Université de Bordeaux I</i>	June 2000
<i>Visiting Professor, Université de Paris-Nord</i>	June 1999
<i>Visiting Directeur de Recherche, CNRS, École Polytechnique</i>	April–June, 1997
<i>Visiting Professor, Université de Nantes</i>	June 1996
<i>Visiting Professor, Institut Fourier, Grenoble</i>	June 1995
<i>Visiting Professor, Université de Paris-Nord</i>	June 1994
<i>Institute des Hautes Études Scientifiques</i>	September 1992–May 1993
<i>Visiting Professor, Université de Paris-Sud, Orsay</i>	May–June 1990

Publications

- [1] “On the Representation of P_0 -lattices Being P -algebras.” (with J. Klukowski), *Demonstratio Mathematica*, **18**(1) (1985), 103–114.
- [2] “Distribution of poles for scattering on the real line” *J. of Funct. Anal.* **73**(3) (1987), 277–296.
- [3] “Decomposition of normal currents.” *Proc. Amer. Math. Soc.* **102** (4)(1988), 831–839.
- [4] “Sharp polynomial bounds on the number of scattering poles of radial potentials.” *J. of Funct. Anal.* **82**(2) (1989), 370–403.

- [5] “Sharp polynomial bounds on the number of scattering poles.” *Duke Math. J.* **59**(2) (1989), 311-323.
- [6] “High frequency scattering by a convex obstacle.” *Duke Math. J.* **61**(2) (1990), 545-634.
- [7] “Shift of the shadow boundary in high frequency scattering.” *Comm. Math. Phys.* **136** (1991), 141-156
- [8] “Complex scaling and the distribution of scattering poles.” (with J. Sjöstrand), *Jour. Amer. Math. Soc.* **4**(4) (1991), 729-769.
- [9] “Distribution of scattering poles near the real axis.” (with J. Sjöstrand), *Comm.PDE* **17** (1992), 1021-1035.
- [10] “The remainder estimate in spectral accumulation for degenerating hyperbolic surfaces.” (with L. Ji), *J. of Func. Anal.* **114** (1993), 412-420.
- [11] “Lower bounds on the number of scattering poles.” (with J. Sjöstrand), *Comm.PDE* **18** (1993), 847-858.
- [12] “Estimates on the number of scattering poles near the real axis for strictly convex obstacles.” (with J. Sjöstrand), *Ann. Inst. Fourier* **43**(3)(1993), 769-790.
- [13] “Semilinear diffraction of conormal waves (joint work with Melrose and Sá Barreto).” Séminaire E.D.P. 1992-1993, École Polytechnique, II-1-II-21.
- [14] “Finite volume surfaces with resonances far from the unitarity axis.” (with R. Froese), *Int. Math. Research Notices* **10**(1993), 275-277.
- [15] “Lower bounds on the number of scattering poles II.” (with J. Sjöstrand), *J. Func. Anal.* **123**(2)(1994), 336-367.
- [16] “Scattering matrix for asymptotically flat manifolds” Journées “Equations aux dérivées partielles” 1994, Saint-Jean-de-Monts, XVII-1-XVII-14.
- [17] “The complex scaling method for scattering by strictly convex obstacles.” (with J. Sjöstrand), *Ark. för Math.* **33**(1)(1995), 135-172.
- [18] “Upper bounds on the number of resonances on noncompact Riemann surfaces.” (with L. Guillopé), *J. Func. Anal.* **129**(1995), 364-389.
- [19] “Semilinear diffraction of conormal waves.” (with R.B. Melrose and A. Sá Barreto), *Astérisque* **240**(1996).
- [20] “An example of new singularities in semilinear interaction of a cusp and a plane.” *Comm.PDE.* **19**(5&6)(1994), 901-909.
- [21] “Polynomial bounds on the number of resonances for some complete spaces of constant negative curvature near infinity.” (with L. Guillopé), *Asymp. Anal.* **11**(1995) 1-22.
- [22] “Counting scattering poles.” *Proceedings of the Taniguchi International Workshop Spectral and Scattering Theory*, M. Ikawa ed., Marcel Dekker, New York, Basel, Hong Kong, 1994.
- [23] “Spectral asymptotics for manifolds with cylindrical ends.” (with T. Christiansen), *Ann. Inst. Fourier* **45**(1)(1995), 251-263.
- [24] “Existence of resonances in three dimensions.” (with A. Sá Barreto), *Comm. Math. Phys.* **173**(2)(1995), 401-415.
- [25] “Ergodicity of eigenfunctions for ergodic billiards.” (with S. Zelditch), *Comm. Math. Phys.* **175**(3)(1996), 673-682.
- [26] “Scattering metrics and geodesic flow at infinity.” (with R.B. Melrose), *Invent. Math.* **124**(1996), 389-436.

- [27] Appendix to “Density of resonances for strictly convex analytic obstacles.” by J. Sjöstrand, *Can. J. Math.* **48**(2)(1996), 437-446.
- [28] “Generic simplicity of resonances.” (with F. Klopp), *Helv. Phys. Acta* **68**(1995), 531-538.
- [29] “Harmonic functions of polynomial growth on some complete manifolds.” (with T. Christiansen), *Geom. and Func. Anal.* **6**(4)(1996), 619-627.
- [30] “Existence of resonances in potential scattering.” (with A. Sá Barreto), *Comm. Pure and Applied Math.* **49**(12)(1996), 1271-1280.
- [31] “Scattering asymptotics for Riemann surfaces.” (with L. Guillopé), *Annals of Math.* **145**(1997), 597-660.
- [32] “Distribution of resonances for spherical black holes.” (with A. Sá Barreto), *Math. Res. Lett.* **4**(1)(1997), 103-121.
- [33] “Poisson formulæ for resonances” Séminaire E.D.P. 1996-1997, École Polytechnique, XIII-1-XIII-12.
- [34] “Distribution of resonances for convex co-compact hyperbolic surfaces” Journées “Equations aux dérivées partielles” 1997, Saint-Jean-de-Monts, XVIII-1-XVIII-9.
- [35] “Dimension of the limit set and the density of resonances for convex co-compact hyperbolic surfaces”, *Invent. Math.* **136** (1999), 353-409.
- [36] “From quasimodes to resonances” (with S.-H. Tang), *Math. Res. Lett.* **5** (1998), 261-272.
- [37] “Wave trace for Riemann surfaces” (with L. Guillopé), *Geom. and Func. Anal.* **6** (1999), 1156-1168.
- [38] “Asymptotic distribution of resonances for convex obstacles” (with J. Sjöstrand), *Acta Math.*, **183**(2) (1999), 191-253.
- [39] “Poisson formula for resonances in even dimensions”, *Asian J. Math.* **2**(3), (1998), 615-624.
- [40] “Spacing between phase shifts in a simple scattering problem”, (with S. Zelditch), *Comm. Math. Phys.* **204** (1999), 709-729.
- [41] “Breit-Wigner approximation and the distribution of resonances near the real axis”, (with V. Petkov), *Comm. Math. Phys.* **204** (1999), 329-351.
- [42] “Resonances in Physics and Geometry”, *Notices Amer. Math. Soc.* **46**(3)(1999), 319-328.
- [43] “Singular part of the scattering matrix determines the obstacle”, *Osaka J. Math.* **38**(2001), 13–20.
- [44] “Distribution of resonances for asymptotically Euclidean manifolds”, (with J. Wunsch), *J. Diff. Geom.* **55**(2000), 43-82.
- [45] “Resonant rigidity of S^2 ” (with A. Hassell), *J. Funct. Analysis.*, **169** (1999), 604-609.
- [46] “The FBI transform on compact C^∞ manifolds”, (with J. Wunsch), *Trans. Amer. Math. Soc.* **353** (2001), 1151-1167.
- [47] “Semi-classical estimates in asymptotically euclidean scattering” (with A. Vasy), *Comm. Math. Phys.* **212**(2000), 205-217.
- [48] “Resonance wave expansions: two hyperbolic examples” (with T. Christiansen), *Comm. Math. Phys.* **212**(2000), 323–336.

- [49] “Resonance wave expansions of scattered waves” (with S.H. Tang), *Comm. Pure Appl. Math.* 53(2000), 1305–1334.
- [50] “Scattering matrices and scattering geodesics of locally symmetric spaces” (with L. Ji), *Ann. Sci. Ec. Norm. Sup.* 34(2001), 441-469.
- [51] “A remark on a paper by E.B. Davies”, *Proc. A.M.S.* 29(2001), 2955-2957.
- [52] “Resonance expansions in semi-classical propagation” (with N. Burq), *Comm. Math. Phys.* 232 (2001), 1-12.
- [53] “Resonance expansions of scattered waves” Séminaire E.D.P. 1999-2000, École Polytechnique, XXII-1-XXII-8.
- [54] Erratum “Breit-Wigner approximation and the distribution of resonances near the real axis”, (with V. Petkov), *Comm. Math. Phys.* **214** (2000), 733-735.
- [55] “A remark on isopolar potentials”, *SIAM J. Math. Anal.* 82(6)(2001), 1823-1826.
- [56] “Semi-classical estimates on the scattering determinant” (with V. Petkov), *Ann. H. Poincaré*, 2(2001), 675-711.
- [57] “Numerical linear algebra and solvability of partial differential equations”, *Comm. Math. Phys.* **229** (2002), 293-307.
- [58] “Quantum resonances in chaotic scattering,” (with Kevin Lin), *Chem. Phys. Lett.* 355(2002), 201-205.
- [59] “Quantum monodromy and semiclassical trace formulae,” (with Johannes Sjöstrand), *J. Math. Pure Appl.* 81 (2002), 1-33.
- [60] “Correction and supplements to: Scattering matrices and scattering geodesics of locally symmetric spaces [Ann. Sci. École Norm. Sup. (4) 34 (2001), no. 3, 441–469]” *Ann. Sci. École Norm. Sup.*(4) 35 (2002), no. 6, 897–901.
- [61] “Scattering matrix in conformal geometry,” (with C. Robin Graham), Séminaire E.D.P. 2000-2001, École Polytechnique, XXII-1-XXII-8.
- [62] “Scattering matrix in conformal geometry,” (with C. Robin Graham), *Invent. Math.* 152(2003), 89-118.
- [63] “Birkhoff normal forms in semi-classical inverse problems” (with Alexei Iantchenko and Johannes Sjöstrand), *Math. Res. Lett.* 9(2002), 337-362.
- [64] “Pseudospectra in automorphic scattering” (with Tanya Christiansen), *Forum Math.* 16(2004), 681-694
- [65] “Fractal Weyl laws for chaotic open systems” (with Wentao Lu and Srinivas Sridhar), *Phys. Rev. Lett.* **91**(2003), 154101.
- [66] “Resonance expansions of propagators in the presence of potential barriers” (with Shu Nakamura and Plamen Stefanov), *J. Funct. Anal.*, **205**(2003), 180-205.
- [67] “Quantum resonances and partial differential equations” Proc. I.C.M. 2002, vol III, 243-252.
- [68] “The Selberg zeta function for convex co-compact Schottky groups” (with L. Guillopé and K. Lin), *Comm. Math. Phys.* 245 (2004), 149 - 176.
- [69] “Pseudospectra of semiclassical (pseudo)differential operators” (with N. Dencker and J. Sjöstrand), *Comm. Pure. Appl. Math.* **57**(2004), 384-415.
- [70] “Geometric control in the presence of a black box” (with N. Burq), *Journal of A.M.S.*, 17 (2004), 443-471.

- [71] “Bouncing ball modes and quantum chaos” (with N. Burq), *SIAM Review*, 47(5), 2005, 43-49.
- [72] “Elementary linear algebra for advanced spectral problems” (with J. Sjöstrand), *Annales de l’Institut Fourier*, 57(2007), 2095–2141.
- [73] “Growth of the zeta function for a quadratic map and the dimension of the Julia set” (with John Strain), *Nonlinearity*, 17(5), 2004, 1607–1622.
- [74] “Instability for the semi-classical non-linear Schrödinger operator” (with Nicolas Burq), *Comm. Math. Phys.*, 260(2005), 45-58.
- [75] “Control theory and high energy eigenfunctions”, (with Nicolas Burq), Journées “Équations aux Dérivées Partielles”, Exp. No. XIII, 10 pp., École Polytech., Palaiseau, 2004.
- [76] “Fractal Weyl laws for quantum resonances.” Séminaire: Équations aux Dérivées Partielles. 2004–2005, Exp. No. IV, 29 pp., École Polytech., Palaiseau, 2005.
- [77] “Quantum decay rates in chaotic scattering”, (with S. Nonnenmacher), Séminaire: Équations aux Dérivées Partielles. 2005–2006, Exp. No. XXII, 6 pp., École Polytech., Palaiseau, 2006.
- [78] “Fractal upper bounds on the density of semiclassical resonances” (with Johannes Sjöstrand), *Duke Math. J.* 137 (2007), 381–459.
- [79] “Distribution of resonances for open quantum maps”, (with Stephane Nonnenmacher), *Comm. Math. Phys.* 269(2007), 311-365.
- [80] “Fractal Weyl laws in discrete models of chaotic scattering” (with Stéphane Nonnenmacher), *Journal of Physics A*, 38 (2005), 10683-1070
- [81] “On dissipation induced destabilization and brake squeal: a structured pseudospectral perspective” (with Oliver O’Reilly, Patrick Kessler, and Annelise Raphael), *Journal of Sound and Vibration*, 308(2007), 1-11.
- [82] “Fast soliton scattering by delta impurities” (with Justin Holmer and Jeremy Marzuola), *Comm. Math. Phys.* 274(2007), 187-216.
- [83] “Soliton splitting by external delta potentials” (with Justin Holmer and Jeremy Marzuola), *J. of Nonlinear Science*, 17(2007), 349-367.
- [84] “Semiclassical L^p estimates” (with Herbert Koch and Daniel Tataru), *Annales Henri Poincaré* 8(2007), 885-916.
- [85] “Slow soliton interaction with external delta potentials” (with Justin Holmer), *J. of Modern Dynamics*, 1(2007), 689–718.
- [86] “Symmetry of bound and antibound states in the semiclassical limit” (with David Bindel), *Lett. Math. Phys.* 81(2007), 107-117.
- [87] “Theory and computation of resonances in 1d scattering” (with David Bindel), online presentation, including MATLAB codes, <http://www.cims.nyu.edu/~dbindel/resonant1d/>
- [88] “Soliton interaction with slowly varying potentials” (with Justin Holmer), *Int. Math. Res. Notices*, 2008 (2008), Art. ID runn026, 36 pp.
- [89] “Breathing patterns in nonlinear relaxation” (with Justin Holmer), *Nonlinearity*, 22(2009), 1259–1301.
- [90] “A mathematical formulation of the Mahaux-Weidenmüller formula for the scattering matrix” (with Tanya J. Christiansen), *J. Phys. A: Math. Theor.*, 42(2009) 415202.
- [91] “Quantum decay rates in chaotic scattering” (with Stéphane Nonnenmacher), *Acta Math.*, 203(2)(2009), 149–233.

- [92] “Semiclassical resolvent estimates in chaotic scattering” (with Stéphane Nonnenmacher), *Applied Mathematics Research eXpress* 2009; doi: 10.1093/amrx/abp003.
- [93] “Probabilistic Weyl laws for quantized tori” (with Tanya J. Christiansen), *Comm. Math. Phys.* 299(2)(2010), 305–334.
- [94] “Effective dynamics of double solitons for perturbed mKdV” (with Justin Holmer and Galina Perelman), *Comm. Math. Phys.* 305(3)(2011), 363–425.
- [95] “Resolvent estimates for normally hyperbolic trapped sets” (with Jared Wunsch), *Ann. Inst. Henri Poincaré (A)*, 12(7)(2011), 1349–1385.
- [96] “From open quantum systems to open quantum maps” (with Stéphane Nonnenmacher and J. Sjöstrand), *Comm. Math. Phys.* 304(1)(2011), 1–48.
- [97] “Control for Schrödinger operators on tori” (with N. Burq), *Math. Res. Lett.* 19(2)(2012), 309–324.
- [98] “Weighted eigenfunction estimates with applications to compressed sensing” (with N. Burq, S. Dyatlov and R. Ward), *SIAM J. Math. Analysis.* 44(5)(2012), 3481–3501.
- [99] “Semiclassical Analysis”, *Graduate Studies in Mathematics* **138**, *American Mathematical Society*, 2012.
- [100] “Quantum ergodicity for restrictions to hypersurfaces” (with S. Dyatlov), *Nonlinearity*, 26(2013), 35–52.
- [101] “A quantitative version of Catlin-D’Angelo-Quillen theorem” (with A. Drouot) *Analysis and Mathematical Physics*, 3(2013), 1–19.
- [102] “Sharp polynomial bounds on the number of Pollicott-Ruelle resonances” (with K. Datchev and S. Dyatlov), *Ergodic Theory and Dynamical Systems*, 34(2014), 1168–1183.
- [103] “Weyl asymptotics: from closed to open systems” (with A. Potzuweit, T. Weich, S. Barkhofen, U. Kuhl and H.-J. Stöckmann), *Physical Review E*, 86, 066205(2012).
- [104] “Pointwise bounds on quasimodes of semiclassical Schrodinger operators in dimension two” (with Hart F. Smith), *Math. Res. Lett.* 20(2013), 401–408.
- [105] “Experimental observation of spectral gap in microwave n-disk systems” (with S. Barkhofen, T. Weich, A. Potzuweit, U. Kuhl and H.-J. Stöckmann), *Phys. Rev. Lett.* 110, 164102(2013).
- [106] “Control for Schrödinger operators on 2-tori: rough potentials” (with J. Bourgain and N. Burq), *J. Eur. Math. Soc.* 15, 1597–1628(2013).
- [107] “Fractal Weyl law for open quantum chaotic maps” (with Stéphane Nonnenmacher and J. Sjöstrand), *Annals of Math.* 179(1)(2014), 179–251.
- [108] “Decay of correlations for normally hyperbolic trapping”, (with Stéphane Nonnenmacher), *Invent. Math.* 200(2)(2015), 345–438.
- [109] “Trapping of waves and null geodesics for rotating black holes”, (with Semyon Dyatlov), *Physical Review D* 88, 084037(2013)[8 pages].
- [110] “Dynamical zeta functions for Anosov flows via microlocal analysis”, (with Semyon Dyatlov), *Ann. Sci. École Norm. Sup.* 49(2016), 543–577.
- [111] “Resonances and lower resolvent bounds”, (with Kiril Datchev and Semyon Dyatlov), *Journal of Spectral Theory*, 5(2015), 599–615.
- [112] “Stochastic stability of Pollicott-Ruelle resonances” (with Semyon Dyatlov,) *Nonlinearity*, 28(2015), 3511–3534.

- [113] “Heat traces and existence of scattering resonances for bounded potentials” (with Hart F. Smith), *Ann. Inst. Fourier*, 66(2016), 455–475.
- [114] “A local trace formula for Anosov flows” (with Long Jin and an appendix by Frédéric Naud), *Ann. Inst. Henri Poincaré (A)*, 18(2017), 1–35.
- [115] “Scattering resonances as viscosity limits” [arXiv:1505.00721](#), to appear in “Algebraic and Analytic Microlocal Analysis”, M. Hitrik, D. Tamarkin, B. Tsygan, and S. Zelditch, eds. Springer.
- [116] “Resonances for asymptotically hyperbolic manifolds: Vasy’s method revisited,” *Journal of Spectral Theory*, 6(2016), 1087–1114.
- [117] “A Fermi golden rule for quantum graphs”, (with Minjae Lee) *Journal of Mathematical Physics*, 57(2016), 092101, 17 pp.
- [118] “Ruelle zeta function at zero for surfaces”, (with Semyon Dyatlov) [arXiv:1606.04560](#), to appear in *Invent. Math.*
- [119] “Mathematical study of scattering resonances,” 7(2017), 1–85.
- [120] “Remarks on Vasy’s operator with analytic coefficients”, (with Gilles Lebeau) to appear in *Proc. A.M.S.*
- [121] “Resonances for obstacles in hyperbolic space”, (with Peter Hintz), [arXiv:1703.01384](#)
- [122] “Wave decay for star-shaped obstacles in \mathbb{R}^3 : papers of Morawetz and Ralston revisited”, (with Peter Hintz), [arXiv:1703.01389](#)
- [123] “A semiclassical approach to the Kramers–Smoluchowski equation”, (with Laurent Michel), [arXiv:1703.07460](#).

Personal Information

Born in 1963 in Wrocław, Poland. Polish and Canadian Citizenships, U.S. Permanent Resident.